

CROMWELL VARLEY'S ELECTRICAL TESTS WITH FLORENCE COOK

Some Notes and Queries

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CROMWELL Varley was an electrician interested in Spiritualism, a Fellow of the Royal Society, and a friend of Crookes. He was born in 1828 at Kentish Town in London, and died in 1883 at Bexley Heath. His father was the eminent water-colour painter Cornelius Varley. His uncle, John Varley, a remarkable personality, was famous, not only as a painter and a teacher of painting, but also as an enthusiastic believer in and practitioner of astrology. Cromwell Varley made many valuable discoveries and inventions in connection with electrical telegraphy in general, and submarine cables in particular; and it was largely owing to him that the second, and successful, transatlantic cable was constructed. He became a Fellow of the Royal Society in 1871 at the age of forty-three, and he was at the height of his powers in 1874, when the experiments with Florence Cook were made.

Varley gave two accounts of these experiments. The first was in a short article in *The Spiritualist* for March 20, 1874, and the second in a book, consisting of statements by many authors, entitled 'Psychic Facts', published in 1880. As the former was written within three weeks of the events recorded, and the latter considerably later, I shall confine my attention to the former. There are several interesting and important items in it which are not mentioned in the synopsis which Mr Hall gives in his book.

Varley's article in *The Spiritualist* is prefaced by an editorial, entitled 'Miss Cook's Mediumship', by W. H. Harrison; and this ends with a copy of a letter, dated March 17, 1874, briefly describing the results of the experiments, which Harrison had sent to the Editor of *The Medium*. This letter, it is stated, had been seen by Varley and by Crookes, and was sent with their approval.

From Harrison's prefatory remarks the following facts emerge. The experiments had been made possible through the good offices of Blackburn and of Luxmoore. There were at least two such experiments, on different days. The first was at Luxmoore's house, and was conducted by Varley, with Crookes present *inter alios*. The second was at Crookes's house, and was conducted by

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him, Varley being absent. Similar results were recorded at both; but, in two respects which I shall describe later, the conditions would appear to have been more rigid at the second than at the first.

Varley had invented the following method for automatically indicating to the sitters whether a medium was or was not still at her place in the cabinet while an alleged materialization was in progress. The medium was placed in her chair in the cabinet, free to move, but was made part of an electric circuit, in which was a 2-cell battery, a resistance-coil, and a reflecting galvanometer. The galvanometer was outside the cabinet and visible to the sitters during the whole of the seance. In order that the current might pass through the medium's body, two sovereigns, to which platinum wires had been soldered, were attached to each of her arms a little above the wrist, by means of elastic rings. Between each sovereign and the skin were three layers of thick blotting-paper, moistened with a solution of Ammonium Nitrate, to insure electrical contact. The platinum wires were attached to the medium's arms and led up to her shoulders, so as to allow her to move her limbs freely. To the upper end of each platinum wire was attached a thin insulated copper wire leading into the room where the sitters and the galvanometer were located. These wires were connected with the two cells of a Daniell's battery, which was the source of current in the circuit.

Under these conditions a current would be passing, and the deflection of the galvanometer-needle would be directly proportional to its magnitude. Since the magnitude of the current would be inversely proportional to the total resistance in the circuit, the galvanometer-reading would be *inversely* proportional to the total resistance. Since the only *variable* resistance in the circuit would be in the medium's body and in the immediate connections of her arms with the rest of the circuit, any *increase* in the galvanometer-reading would indicate a *decrease* of resistance in one or the other or both of those places. Conversely, any *decrease* in the *galvanometer* reading would indicate an *increase* of resistance in that part of the circuit. If she were to break the circuit, even for an instant, the galvanometer reading would immediately fall to zero. If, without ever breaking the circuit, she should bring the two contacts together and fasten them in that position, preparatory to slipping her hands out of the circuit, the galvanometer reading would immediately increase considerably, and would remain so until she should resume her place in the circuit.

These seem to be the only possibilities considered by Harrison and by Varley. But there is plainly at least one other, which Mr

Hall suggests. Suppose that the medium were provided beforehand with a resistance-coil of about the same resistance as that of her body together with the connections to her skin; and suppose that she were to try to substitute this for her body in the circuit, in order to emerge from the cabinet in the guise of a materialization. Unless she were extraordinarily skilful and lucky, there would be sudden jumps, one way or the other, in the galvanometer-deflection at the critical moment. If she disconnected herself for an instant before introducing the resistance-coil, the galvanometer would momentarily show a zero reading and then jump back to about what it was immediately before. If, on the other hand, she so managed that there was never a complete break in the circuit, she might momentarily put the resistance-coil either in *series* or in *parallel* with herself before withdrawing her arms from the circuit. In the former case, the effective resistance at that point in the circuit would momentarily be about *doubled*, and the galvanometer reading would suddenly *diminish*. In the latter case, the effective resistance at that point would momentarily be about *halved*, and the galvanometer reading would suddenly *increase*. In either case it should get back to about what it was immediately before the medium had begun these operations, and should then remain steady until she resumed her position in the chair and began detaching the resistance-coil and re-introducing her body into the circuit. At that stage one might expect sudden considerable fluctuations in one direction or the other.

In the case of a fraudulent medium, then, provided with a suitable resistance-coil and with instructions how to use it and skill in doing so, one would expect *sudden variations* in the galvanometer-reading *shortly before* the ostensible materialization emerged, *constancy* of reading *while* the figure was out and about, and again *sudden variations* after it had re-entered the cabinet and shortly before the sitters were admitted to the medium's presence. Unfortunately, as it seems to me, one might expect very much the same behaviour on the part of the galvanometer, if the medium were *not* fraudulent and the materialization were genuine. If, as Spiritualists hold, the materialized spirit derives some or all of its substance from the medium's body, it would surely be surprising if the electrical resistance of the latter did *not* change suddenly when the materialization began, and again when it ended. So it seems to me that we are neither here nor there with Varley's method of control. All that one can say is that a sudden complete *drop to zero* on the part of the galvanometer at the beginning of an alleged materialization would be a highly suspicious circumstance.

There is a further complication to be noted. As Varley points

out, the solution on the bits of blotting-paper, which make the electrical connection with the medium's arms, slowly evaporates as the sitting goes on. This will cause a steady increase in the resistance of the circuit, which will be indicated by a steady decrease, throughout the sitting, in the deflection of the galvanometer-needle. (That is, of course, on the assumption that the medium honestly sits as she was placed, and does not attempt to 'monkey with' the connections.) The following two consequences should be noted:

(i) Suppose that the medium is dishonest, and that a collaborator has supplied her beforehand with a resistance-coil, which she is to introduce, instead of her own body, into the circuit, when about to fake a materialization. How great should that resistance be? Suppose it were equal to that of her body *plus* that of the contacts in their original damp state at the beginning of a sitting. At a later stage, when the bits of blotting-paper have partially dried out, the total resistance in the circuit will have increased, and will therefore be greater than that of the coil with which the medium has been supplied. If, then, she should substitute the resistance-coil at that stage for her own body and the by then half-dried contacts, there will be a sudden *decrease* of resistance, indicated by a sudden *increase* in the galvanometer-deflection. Therefore, any such sudden increase in the deflection, following upon a steady decrease in it, and immediately preceeding an ostensible materialization, would strongly suggest fraud of the kind supposed.

(ii) Suppose, further, that the galvanometer-deflection should remain *constant* whilst the ostensible materialization is outside the cabinet, whilst it has been steadily falling before the emergence of the figure, and steadily falls again after its re-entry. That would be a strong indication of trickery of the kind suggested. For a coil introduced into the circuit in place of the medium's body would, of course, maintain a constant resistance so long as it was there.

Before going further it will be worth while to establish a simple formula, connecting the variable resistance at any moment in the course of an experiment with the galvanometer-deflection at that moment. Let R be the *permanent* resistance in the circuit, and let D be the deflection before the medium's body is connected up, when this is the *only* resistance present. At a time t after the beginning of an experiment, with the medium in circuit, let the variable resistance be r_t , and let the deflection be d_t . Assuming that the E.M.F. of the battery is constant throughout, and that the deflection is proportional to the current passing through the galvanometer, we have, by Ohm's Law, the equation

$$DR = d_i(R + r_i)$$

whence

$$r_i = R(D - d_i)/d_i \quad (I)$$

It will be useful also to have a formula expressing, in terms of the galvanometer-deflections, the ratio of the *difference between the value of the variable resistance at any given stage of the experiment and its initial value*, to its initial value, i.e., the ratio $(r_i - r_o)/r_o$. From equation (I) this is easily shown to be

$$(r_i - r_o)/r_o = D(d_o - d_i)/d_i(D - d_o) \quad (II)$$

This can, of course, be expressed as a percentage, by multiplying it by 100.

So much for the elementary physics of the experiments. We can now consider what actually happened in the case of Florence Cook when tested by Varley. He tells us that the constant resistance consisted of a coil of 39,000 ohms, together with the internal resistance of the galvanometer, which was 10,000 ohms. (We can neglect the internal resistance of the cells, which, he says, amounted only to about 8 ohms.) So $R = 49,000$ ohms. Varley passed a current through this, before connecting the medium into the circuit, and noted that the deflection was 300. So $D = 300$. (After the medium had been removed from the circuit at the end of the experiment he repeated this procedure. The deflection was then 297.5. So it is safe to assume that the E.M.F. was practically constant throughout the experiment.) When the medium was first introduced into the circuit and had settled down, the deflection was 220. Substituting these values for R , D , and d_o in (I), we find that $r_o = 17,819$ ohms.

Varley states, that, before the medium became entranced and the séance proper began, but after she had been introduced into the circuit, he got her to move her arms about fairly vigorously, in order to see what effect this would have on the deflection. He found that it produced fluctuations of '15 to 30 divisions, and sometimes more'. This he ascribes to variations in the amount of metallic surface in actual contact with the blotting-paper and the skin during such movements. If we substitute the value 300 for D , and the value 220 for d_o in (II) we find that an *increase* of 30 divisions in the deflection would mean a *decrease* of 45% in the initial variable resistance: whilst a *decrease* of 30 divisions in the deflection would mean an *increase* of roughly 59% in the initial variable resistance. Sudden variations of about this order of magnitude in the course of the séance might therefore reasonably be ascribed to fairly vigorous movements of the medium's arms, assuming her to be still in the circuit.

As to the details of the arrangements at the séance, Varley gives the following information. The séance was at J. P. Luxmoore's house, 19 Gloucester Square, Hyde-Park. The back drawing-room was used as the cabinet. The doors of it were locked and the room was searched before the séance began. The sitters were in the front drawing-room and the two rooms were separated by heavy curtains. The back room was in complete darkness; the front room was illuminated by a shaded paraffin lamp, turned low. The galvanometer was on the mantelpiece of the front room, ten feet or so from the curtains. There was a table in the front room. Varley was at one end of this, ten or eleven feet from the curtain. He remarks, '... only once was I allowed to go nearer, viz., a minute or two before the séance was over.' It was only 'towards the close of the séance', when 'the room was darkened' that 'Katie allowed' Varley 'to approach her'. (We shall consider below what happened then.) The persons present as sitters, beside Varley himself, were Luxmoore, Harrison, Crookes and Mrs Crookes, a Mr G. R. Tapp, and Florence's mother Mrs Cook. Crookes and Luxmoore sat close to the curtain, the one at one edge and the other at the other edge. Varley was mainly occupied throughout the séance with watching the 'bright reflected image from the galvanometer'. He dictated the readings from time to time to Harrison, who was provided with a chronometer, and recorded what Varley dictated (together with any comments that Varley might make) and the time concerned.

It would not appear from Varley's statements that the figure of the ostensible 'Katie King' ever emerged *as a whole* into the front room. She seems to have done no more than to show her face, now at one edge of the curtain and now at the other; to extend her arms and hands; to put her hand on Crookes's head; and eventually to write (in sight of the sitters) on paper provided by them, which, after completing her writing, she threw at Mrs Cook. As to his own observations on the ostensible 'Katie', Varley makes the following statements. Owing to his eyes being fixed most of the time on the brightly illuminated image of the galvanometer-needle, he was less sensitive than the other sitters to what was visible in other parts of the dimly lighted outer room. But at a certain stage, when he looked at the face of the ostensible 'Katie' 'the lamp was for a few seconds turned up to let' him 'have a better view'. He thought that the face was much like that of Florence Cook, and he remarked: 'You look exactly like your medium.' To this the ostensible 'Katie' answered 'Yeth, yeth'. (One wonders whether there is any other record of either Florence or the ostensible 'Katie' having *lisp*ed.) Towards the close of the séance the room

was darkened, i.e., presumably, the already feeble illumination by the paraffin lamp was either completely extinguished or was made still feebler than before. At that stage 'Katie allowed' Varley 'to approach her'. She let him grasp her hand, and he noted that it was a *long* one, very *cold* and *clammy*. A minute or two later 'Katie' told Varley to go into the cabinet and get Florence out of her trance. He entered (presumably still in complete darkness), and found Florence in a deep trance, huddled together in her easy chair, her head lying upon her left shoulder, and her right hand hanging down. He felt the hand, and noted that it was 'small and dry, and not long, cold, and clammy like Katie's'. The sovereigns, blotting-paper, and wires were exactly as he had left them at the beginning of the seance, viz., attached to the medium's arms by bits of elastic. She came out of her trance in the course of two or three minutes, and thereupon Crookes and Luxmoore came in with a light.

It should be noted that Varley says that he was so much exhausted after the seance that he had felt obliged to discontinue personal participation in the experiments. He remarks that he is always thus affected by physical seances, whilst Crookes is unaffected by them. In this connection, he adds in parenthesis: 'I have lent my apparatus to Mr. Crookes, and have been to his house and tested the apparatus before Mr. Crookes, using his son (who is not a medium) in place of Miss Cook, who was not present.' It is not clear from this passage whether Varley *had* already done this *before* the experiment in Luxmoore's house, which he is describing, or whether he had done so *after* that experiment. It seems to me that the more plausible interpretation of his statement, in its context, is the latter. Surely the natural interpretation is that Varley, having decided that he could not personally take part in further experiments, because they would be too exhausting for him, and having decided to hand over further experimentation to Crookes, had taken his apparatus to Crookes's house and had given a demonstration there, using Crookes's son as 'guinea-pig', in order to instruct Crookes how to proceed in future experiments.

Varley's account of the characteristically different size and 'feel' of the hand of the ostensible 'Katie' and that of Florence, as grasped by him on two very closely successive occasions, is obviously of considerable interest and importance. If one wants to minimize it or to try to explain it away altogether, one would, I suppose, have to suggest that Varley's admitted state of exhaustion towards the end of the seance was such that he was by then liable to hallucinations of touch.

We can now consider the recorded behaviour of the galvano-

meter during Varley's experiment. The seance began at 7.10 p.m., and ended at 7.48 p.m. Varley noted the galvanometer-deflections at various times during this period of 38 minutes; whilst Harrison

T	d _t	t	Phenomena observed
0-2	220 200 250		
2-4 4-5 5-6	220 210 220		
6-15	200 (initial) 189 (final) (Max. 200, min. 189) (Mean 193.3, s.d. 2.8)	12	'K' heard whispering
15-16	191 186 176 174 171		
16-26	155 (initial) 152 (final) (Max. 157, min. 148) (Mean 153.3, s.d. 2.2)	17 19 19.5 20 21	'K' looks out on side next to Luxmoore 'K' looks out on side next to Luxmoore 'K' looks out on side next to Luxmoore 'K' shows one hand 'K' shows herself for a moment
26-27	135 150	26 26.5	'K' shows hand and arm 'K' shows both arms, and freely moves them
27-35	156 (initial) 158 (final) (Max. 158, min. 155) (Mean 156, s.d. .912)	28 29 32	'K' appears on side next to Crookes, and shows both arms 'K' puts hand on Crookes's head. It feels cold 'K' puts out arm at full length, asks for pencil and paper, writes and then throws paper at Mrs Cook. At V's request moves wrists, and opens and closes fingers.
35-38	146 (initial) 150 (final) (Max. 150, min. 146) (Mean 148.4, s.d. 1.35)	35	'K' repeats experiment of moving wrists and opening fingers. Crookes draws attention to moans coming from Florence.
38	146	38	End of seance. Medium found with connections intact and in place.

recorded the times, the deflections, and any observations which Varley might make on the circumstances prevailing on any occasion. These are presented in a Table in the article in *The Spiritualist*. I summarize the most important points in the Table given above. For any period during which the deflections varied but little, I have given the *initial* and the *final* values, and I have added the *mean* and the *standard-deviation*. The time-lapse is in *minutes* from the beginning of the seance.

I will now make some remarks on the above Table:

(1) The total period of thirty-eight minutes falls into eight successive sub-periods of various lengths.

(i) In the first two minutes there is a substantial fall, followed immediately by a substantial rise to a considerably higher value than the initial one of 220. Probably this is due to movements of the medium's arms altering the area of contact with her skin.

(ii) In the next four minutes the initial value of 220 is again resumed, then there is a momentary drop of 10 points, and then the original deflection of 220 is regained. Probably this too is due to movements of the medium's hands and arms.

(iii) At the beginning of the third period, which lasts for nine minutes, there is a sudden drop of 20 points from the terminal value of the immediately previous period to an initial value of 200. Thereafter there is a fairly steady slow fall to a final value of 189. It is shortly after the middle of this period that whispering is heard from behind the curtain in a voice which the sitters claim to recognize as that of 'Katie'. It seems reasonable to ascribe this slow steady fall in the current to a slow steady increase in the resistance, due to evaporation of the solution on the blotting-paper.

(iv) The fourth period, which begins three minutes after the whispering is first heard, lasts only one minute. It is occupied by a continuous and rapid fall of 20 points from 191 to 171. Nothing is seen or heard of 'Katie' during this period.

(v) At the beginning of the fifth period, which lasts for ten minutes, there is a sudden dramatic fall of 16 points from 171, the final value of the fourth period, to the initial value of 155. During the whole of this period the deflection is remarkably steady, and ending at 152. One minute after the beginning of this period 'Katie' looks out from the curtains for the first time. She repeats this twice, then shows a hand, and then shows herself for a third time for a moment, all within the first five minutes of the period.

(vi) The sixth period, which lasts only for one minute, begins with a further sudden and dramatic fall of 17 points, from 152, the final value of the fifth period, to the initial value 135. This is

immediately followed by a rise of 15 points to the final value of 150, which is comparable to the mean value in the fifth period (153.3) and to the mean value in the seventh period (156). During this brief period of one minute 'Katie' first shows one hand and arm, and then shows both arms and moves them freely.

(vii) At the beginning of the seventh period, which lasts for eight minutes, the deflection is up to 156. Thereafter it keeps remarkably steady, never falling below 155 or rising above 158, which is its final value. During this period 'Katie' is highly active. Within the first three minutes she has appeared at the side of the curtain next to Crookes, has shown both arms, and has put a cold hand on Crookes's head. Three minutes later she has put out her arm at full length, has asked for and received pencil and paper, has written, and has thrown the paper at Mrs Cook. She has also, at Varley's request, moved her wrists and opened and closed her fingers.

(viii) The eighth and concluding period, which lasts for three minutes begins with a drop of 12 points to the initial value of 146 from 158, the final value of the seventh period. Thereafter it remains fairly steady to the end of the seance. At the beginning of this period 'Katie' repeats the experiment of moving her wrists and opening her fingers by request. Crookes meanwhile draws attention to the sounds of moaning which are coming apparently from Florence behind the curtain. These, according to Varley, were heard by all the sitters.

(2) The rapid continuous fall of 20 points from the 15th to the 16th minute, followed immediately by the sudden further fall of 16 points to 155, i.e., a drop of 36 points in little more than a minute, is evidently highly significant. It was followed immediately by the first appearance of 'Katie', and thereafter visible manifestations were going on for the next four minutes. It will be noted that the deflection never rose again, throughout the rest of the seance, to more than three points above the value 155 to which it had then fallen. It appears from formula (I) that the fall in deflection from 191 to 155 represents an increase in the variable resistance from 28,000 to 45,900 ohms, i.e., an increase of 64% in less than two minutes. If we are inclined to think that the medium cheated, it is tempting to suppose that during this period she disengaged her wrists from the connections and substituted a resistance-coil of 45,900 ohms, which she had brought with her to the seance. This would fit in with the remarkable steadiness of the galvanometer-deflections during the rest of the seance, and in particular during the period of maximum activity by 'Katie'.

(3) But, when we come to consider this suggestion in detail, we

find very great difficulties in it. In the first place, since there was never for an instant a complete break in the current through the galvanometer, there can be no question of the medium first disengaging herself, and then (no matter how soon afterwards) introducing the resistance-coil into the circuit instead of herself. It would seem therefore that there would have had to be a period during which *both* the medium and the supposed coil were in circuit together. If so, they must have been for that brief period either in *series* or in *parallel*. Let us consider these two alternatives in turn.

(i) Suppose that the two were in series for a short time. Then at the beginning of that period the variable resistance would have been suddenly increased from 28,000 ohms to $28,000 + 45,900$ ($=73,900$) ohms, at the moment when the coil was introduced. And it would have gone down to 45,900 ohms at the moment when the medium withdrew herself from the circuit. From formula (I) it follows that the galvanometer-deflection would have dropped to 120 and then risen to 155. Nothing of the kind was observed.

(ii) Suppose then, that the two were in parallel for a short time. If two resistances R_1 and R_2 are in parallel, the effective resistance is given by the formula:

$$R = R_1 R_2 / (R_1 + R_2)$$

It is therefore less than the lesser of the two. Using this formula, we find that the effective resistance would have *gone down* from 28,000 ohms to 17,400 at the time when the medium introduced the supposed coil in parallel with herself. And it would, of course, have *gone up* to 45,900 ohms at the moment when she withdrew herself from the circuit. From formula (I) it follows that the galvanometer-deflection would have risen to 221 and then fallen to 155. Nothing of the kind was observed.

We are not at the end of our difficulties. On the present hypothesis the medium must, in the last few minutes of the séance, have managed to withdraw the supposed resistance-coil from the circuit, to conceal it about her person, and to re-introduce herself into the circuit in such a way that it appeared to Varley, on inspection, that his initial connections had been undisturbed. On any view of the *modus operandi* this process might be expected to be accompanied by substantial variations in the galvanometer-deflection. No such variations were observed at that stage.

There is at least one further difficulty to be noted in the hypothesis at present under discussion. At the beginning of the sixth period (from the 26th to the 27th minute of the séance) there was a sudden fall of 17 points (from 152 to 135) in the deflection. This

was followed almost immediately by a rise of 21 points in all (first from 135 to 150, and then from 150 to 156). Now this period of rapid and substantial fluctuation falls within the period during which, on the present hypothesis, the medium is out of the circuit and is replaced by a resistance-coil. If the remarkable *constancy* of the deflection during this period as a whole is adduced in *favour* of the hypothesis, this remarkable *fluctuation* at a short segment within the period must equally be adduced *against* it.

4. It is plain that Varley himself either never envisaged the possibility of fraud by temporary substitution of a resistance-coil for the medium's body, or, if he did, dismissed the idea as impracticable. The only kind of fraud that he envisaged was that the medium, *whilst remaining in circuit* might rise from her chair, come forward to the curtain, and there impersonate 'Katie'. (It may be remarked that that is the suggestion which Podmore makes in his account of these experiments in his 'Modern Spiritualism'. He concludes (Vol. II, p. 157) with the remark: 'There is really nothing in the record to forbid the supposition that Miss Cook left her seat and promenaded as 'Katie' with the wires still attached to her wrists'.) What are we to say of this?

(i) I think that the following two things are pretty certain, though they are not explicitly stated.

- (a) The wires connecting Florence into the circuit must have been long enough to allow of her coming as far forward into the outer room as the ostensible 'Katie' did, without breaking the circuit, and
- (b) The light in the outer room must have been so dim that it would not have been immediately obvious by sight to the sitters that the figure had wires attached to its wrists, if it in fact did have them.

I say that these two propositions are fairly certain, for two reasons. In the first place, unless both these conditions had been fulfilled, there would have been no reason for Varley to adduce (as he triumphantly did) *indirect electrical* evidence to show that the figure was not that of the medium, still connected into the circuit. He would simply have said: 'The wires were too short; and, anyhow, the presence of connexions attached to the figure's wrists would have been easily visible to the sitters.' Secondly, Harrison, in his editorial preface to Varley's article, refers to a second sitting, at which the experiment was conducted by Crookes, and Varley was absent. He states that Crookes obtained similar results, 'but allowed only enough slack wire to permit the medium, had she moved, to appear at the opening of the curtains of the dark room . . .'. Plainly, the implication is that, on the former occasion,

i.e., when the experiment was conducted by Varley, there was more slack wire than this.

(ii) We can now consider the electrical evidence adduced by Varley, and the argument underlying it. The essential point is this. Before the seance began, but after connecting the medium into the circuit, Varley had got her to make vigorous movements with her hands and arms. He had found that these movements caused fluctuations of '15 to 30 divisions and sometimes more' in the galvanometer-deflection. At the 32nd minute of the seance, when the ostensible 'Katie' had been writing, Varley requested her to move her wrists and open and close her fingers. She did so. At the 35th minute he requested her to repeat these movements, and she again did so. On neither occasion was there any substantial fluctuation in the galvanometer-deflection.

The argument, then, is this. The ostensible 'Katie', on request, made movements of the hands and arms comparable in kind and in magnitude to those which the medium had made, on request, when connected into the circuit before the seance began. These movements of the ostensible 'Katie' produced no appreciable fluctuations in the deflection, whilst the similar movements of the medium had caused substantial fluctuations. Therefore, the supposition that the ostensible 'Katie' was simply the medium, still in circuit, is untenable.

Mr Hall accuses Varley of 'confusion of thought about the object of his test'. I cannot see that there is any confusion; the argument seems to me to be perfectly sound for the purpose for which it was intended. Podmore does not challenge the *logic* of the argument, but he seems to me to have ignored an essential part of the *premises*. He says, '... the assumption made by Mr. Varley that the act of writing (during which, of course, the arms would experience no sudden or violent motion) would necessarily have involved oscillation, appears to have been purely gratuitous.' This ignores Varley's explicit statement: 'Katie then, at my request, moved her wrists, opened and closed her fingers, but the galvanometer was steady the whole time. ... The opening and closing of her fingers did not cause any variation exceeding one division of the scale; had it been Miss Cook's hand, the galvanometer would have varied at least 10 divisions.'

So much for the experiment which Varley himself conducted, and at which Crookes was merely one of the sitters. As already mentioned, Harrison, refers to a second experiment, performed on a later occasion, at which Crookes was the experimenter and Varley was absent. As stated above, he alleges that Crookes allowed only enough slack wire to permit the medium, had she moved, to

appear at the opening of the curtains of the dark room used as a cabinet. He alleges that, in spite of this, the figure 'came six or eight feet outside the curtains, into the room. ...'. He states also that Crookes got 'Katie' to dip her hands into a solution of potassium iodide, and that this caused no change in the galvanometer-deflection. If all this is true, it certainly follows that *either* 'Katie' was not identical with the medium, *or* the medium was no longer in circuit, and some equivalent resistance had been substituted temporarily for her body. We have no data for deciding between these two alternatives.

I must say that I find the whole thing extremely puzzling. In view of what we know of Florence's earlier and contemporary associates and of her later history, it is antecedently probable that she was cheating on this occasion. But I cannot think of any obvious way, consistent with the observations, in which she might have done so. I must content myself with the following hypothetical remarks. Let us suppose, what I have tried to show above to be very hard to reconcile with the recorded behaviour of the galvanometer, that she cheated by means of temporarily substituting a resistance coil for her own body in the circuit. That would presuppose, on the medium's part, the possession and concealment of a suitable resistance-coil, knowledge of how to use it, and considerable skill in making the two substitutions without on either occasion breaking the circuit. In 1874 electrical apparatus was a rarity, and familiarity with its working was confined to a few experts. There cannot have been many persons in Florence Cook's circle who would have the technical knowledge and the material resources to provide Florence with the means of cheating in this way, and with the training needed to enable her to use them successfully. *One* such person would obviously have been Crookes, but he need not have been the *only one*. *If*, then, we think (in spite of the difficulties which I have pointed out in reconciling that hypothesis with the recorded facts) that Florence was cheating in this way when tested by Varley, and *if* we suppose that Crookes was the only person in her circle with the necessary qualifications to enable her to do so, it will not be easy to resist the inference that Crookes was her witting accomplice. But it is fair to say that the first of these two hypotheses is by no means probable, and that the second of them is by no means certain.

It is of some interest to note that Serjeant Cox, in a letter published in *The Spiritualist* for July 10, 1874, states that Crookes had applied Varley's electrical test to Mary Showers, and that he had proved by it that 'Florence Maple' was identical with Mary. Now, as we know, Harrison had stated, in his letter of March 17,